Planning for Photo Events

Tyler Evans 11/4/2015

Outline

1. Camera Angle of View
   - Full Frame vs "Crop Sensor" and table of camera/lens options
2. Calculating Distance on Maps
   - Angle of View Photo Shoot Examples
   - Trigonometry is useful
3. Perspective of Different Sizes at Different Distances
   - Angular Size of Sun and Moon, "**Size Matching Equation**", and examples
4. Let Technology Do the Work
   - The Photographers Ephemeris (TPE) & PlanIt! for Photography
5. Total Solar Eclipse Opportunities & Sun Setting in the City Streets (CityHenge)
6. Rules of Thumb Review

Camera Angle of View

Start thinking of your photo borders in angular size

Crop Factors for Different Cameras

Sensor Size	1/3"	1/2.5"	1/1.7"	4/3"	Canon APS-C	Nikon, Sony, Pentax APS-C
Crop Factor	7.21	6.02	4.55	2	1.62	1.54
Examples	iPhone 5s iPhone 6	Sony Cybershot	Canon G10, G15	Four Thirds Cameras	Canon Rebel 70D, etc	Nikon D3200, D3300, D5300 Sony Alpha 37, 57, 65 Pentax K-3, K-S1, etc

- The calculations on the slides to follow use 1.62 crop factor (Canon APS-C)
  - There is a 5% difference between the Canon and Nikon/Sony Crop Factors
- You can divide the numbers in the Full Frame table on the top half of the next page to create a new bottom half table for your camera's "crop factor"

Calculating Angle of View

- $\propto = 2 * Arctan\left(\frac{d}{2f}\right)$ Camera Angle $= 2 * Arctan\left(\frac{Sensor\ size\ (mm)}{2 * Equivalent\ 35mm\ Lens\ Focal\ Length}\right)$
- Note: Human Eye can see 140° by 80°, Moon is 0.5°

Focal Length (mm)	16	35	50	70	85	105	200	300	400	600	800	1200
Full Frame DSLR Sensor (35mm Equivalent) = 36mm x 24 mm												
Vertical (Degrees)	73.9	37.8	27.0	19.5	16.1	13.0	6.87	4.58	3.44	2.29	1.72	1.15
Horizontal (Degrees)	95.1	54.4	39.6	28.8	23.9	19.5	10.3	6.87	5.15	3.44	2.58	1.72
Canon DSLR Crop Sensor (APS-C) = 22.2 mm x 14.8 mm (Nikon APS-C slightly bigger at 23.6mm x 15.7mm, but table values below are for Canon size) Canon APS-C = Full Frame / 1.62 Nikon / Sony APS-C = Full Frame / 1.54 (Nikon Values should be 5% bigger than below table values)												
Vertical (Degrees)	49.6	23.9	16.8	12.1	10	8.1	4.2	2.8	2.1	1.4	1.1	0.7
Horizontal (Degrees)	69.5	35.2	25	18	14.9	12.1	6.4	4.2	3.2	2.1	1.6	0.8

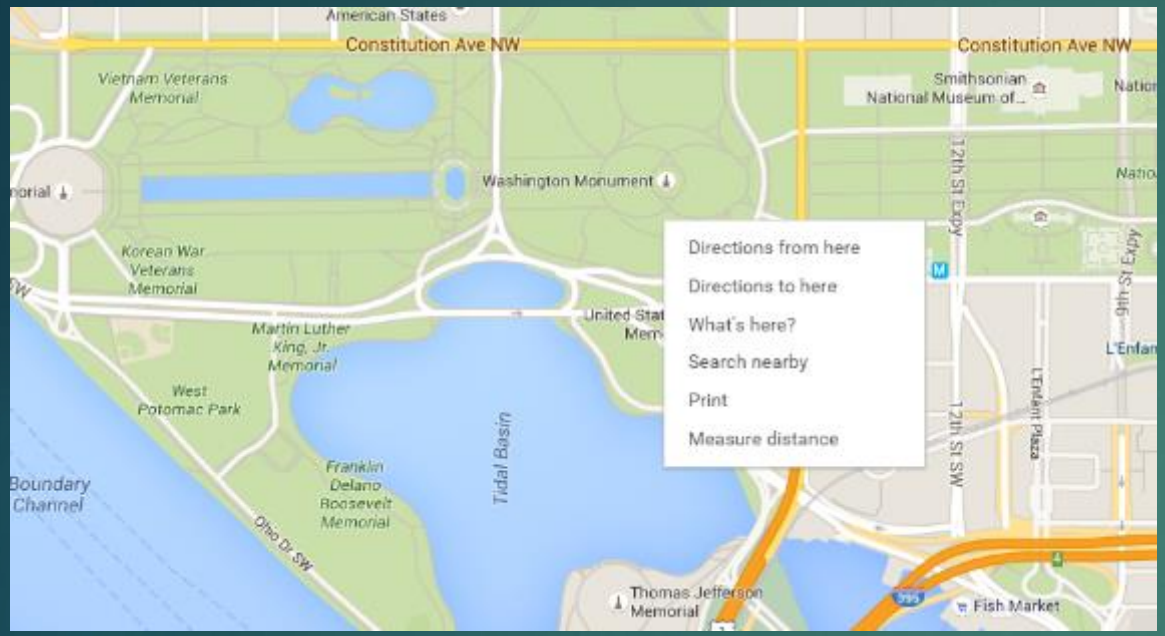
- *Example for* **85mm**: $\frac{Full\ Frame\ Angle}{Crop\ Factor}$ = APS-C Angle $= \frac{16.1}{1.6} = 10$

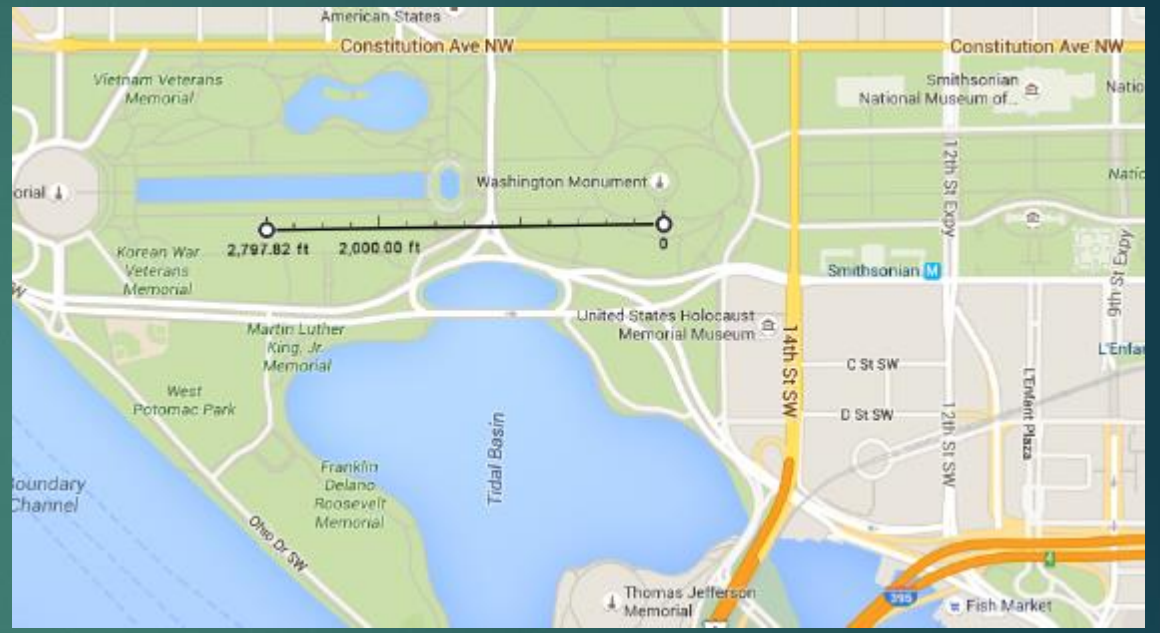
https://en.wikipedia.org/wiki/Angle_of_view
https://en.wikipedia.org/wiki/Image_sensor_format

Calculating Distances on Maps

Aren't you glad you learned trigonometry?

Calculating Distance on Maps

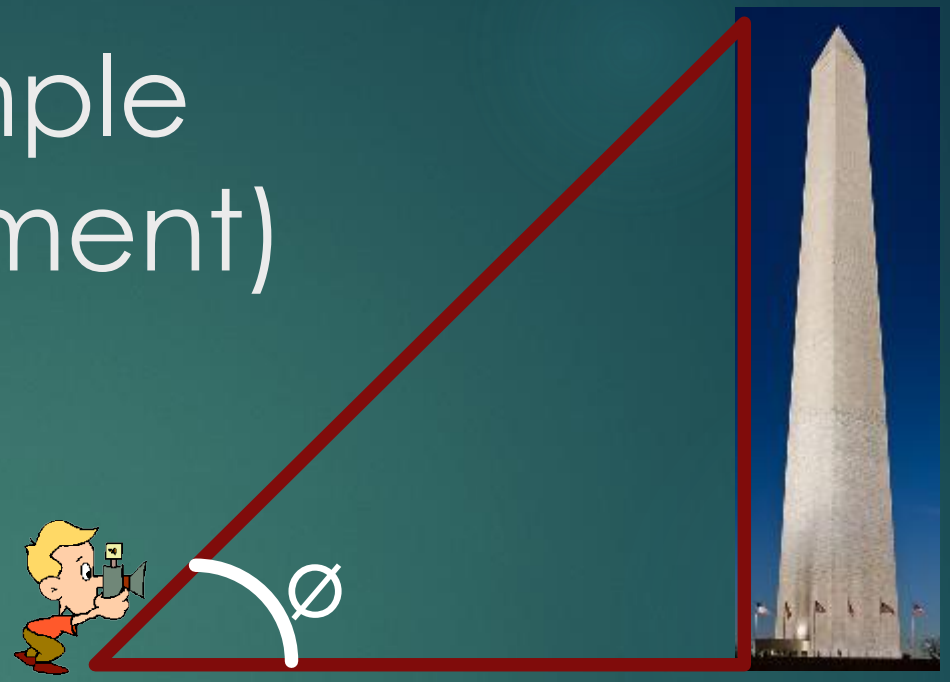




- On Google Maps, right click anywhere on a map and click "measure distance" on what you want to photograph

- Drag your mouse to where you want to stand to take the photo (or until you are the correct distance away)

Angle of View Example (Washington Monument) **WIDE ANGLE 35mm**



<u>How far away do you need to be to fit the entire Washington Monument in your photo?</u>

- Washington Monument is 555 feet tall

- tangent(ø) = opposite / adjacent

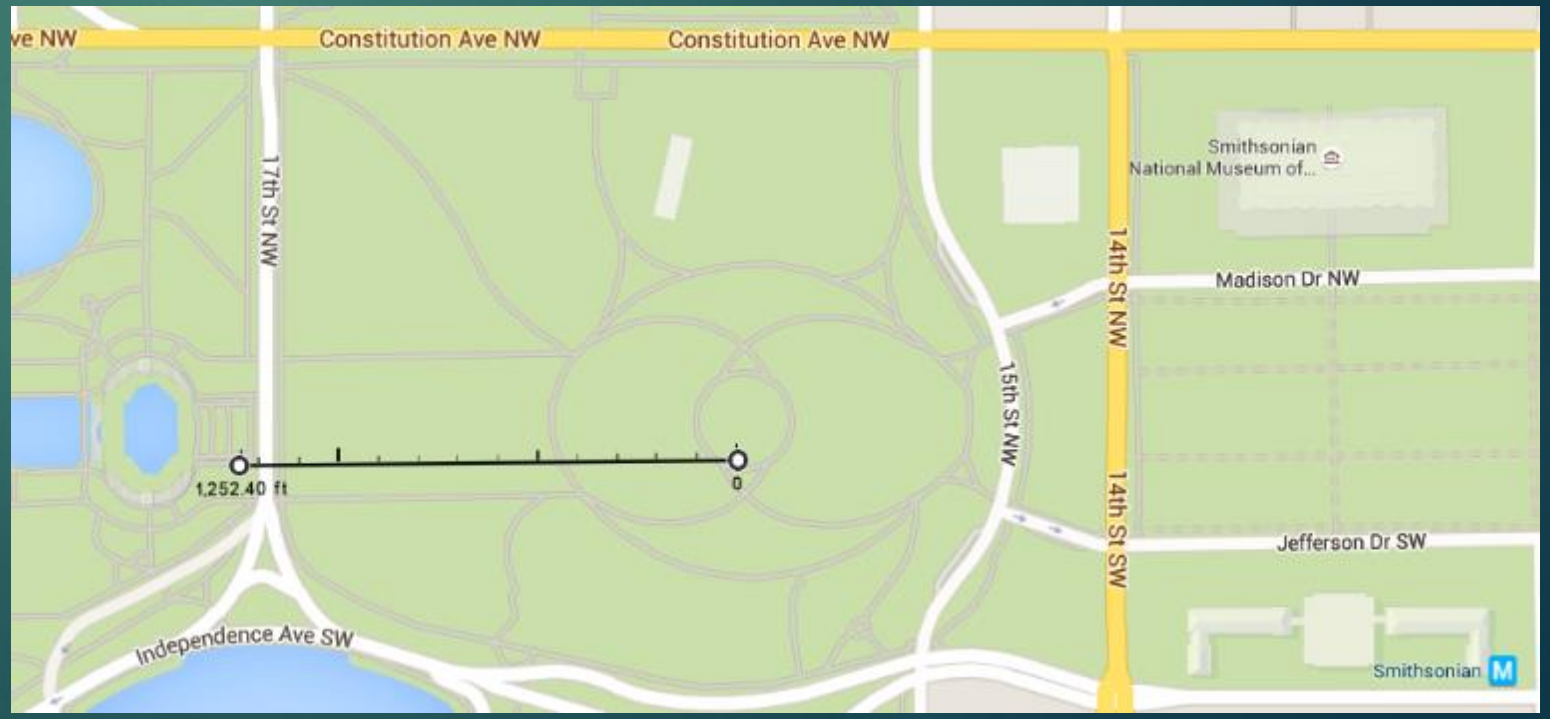
  tangent(ø) = (Height of Monument) / (Distance to Monument)

  (555 feet) / tangent(ø) = Distance to Monument
  - 35mm crop lens, vertical angle = 23.9°, therefore 555 / tan(23.9°) = 1,252 feet (0.24 miles)

- Must be 1,252 feet (0.24 miles) away from Washington Monument with 35mm lens on a Canon crop DSLR
  - (Nikon/Sony would be 5% closer, or 60 feet closer)

Example

- Washington Monument filling the camera frame of a crop sensor DSLR with a 35mm lens needs to be 1250 feet away
  - Across 14th street towards the Capitol Building
  - Across 17th street near WW2 Memorial entrance



Angle of View Example (Washington Monument) **TELEPHOTO 300mm**

<u>How far away do you need to be to fit the entire Washington Monument in your photo?</u>

- Washington Monument is 555 feet tall

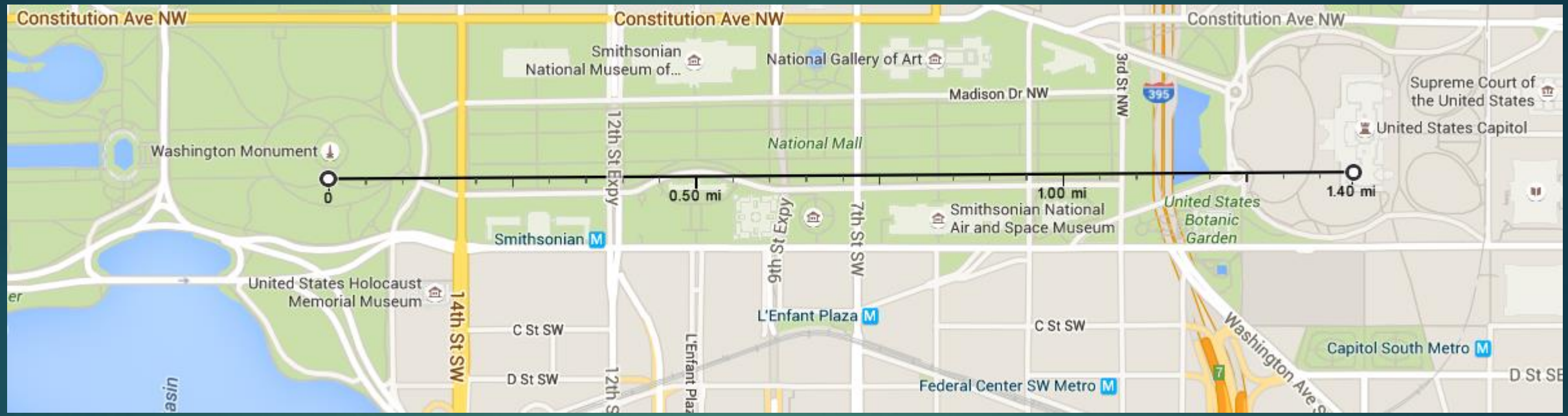
- tangent(ø) = opposite / adjacent

  tangent(ø) = (Height of Monument) / (Distance to Monument)

  (555 feet) / tangent(ø) = Distance to Monument
  - 300mm crop lens, vert angle = 4.2°, therefore 555 / tan(4.2°) = 7,560 feet (1.4 miles!)
  - Can achieve same result with 200mm lens, turn camera 90° for portrait instead of a landscape

- Must be 7,560 feet (1.4 miles) away from Washington Monument with 300mm crop lens horizontal (or 200mm crop lens vertical)

Example



- Washington Monument filling the camera frame of a crop sensor DSLR with a 300mm lens needs to be 7,560 feet away
  - From the steps of the Capitol Building
  - From across the river behind the Lincoln memorial on the Arlington, VA side (couldn't see through Lincoln memorial)

Perspective of Different Sizes at Different Distances

Size is in the eye of the beholder
(depending on how far away that beholder is)

Angular size of the Moon and Sun

- For the sun and moon, you can assume a constant angular distance
  - Distance to sun and moon is so large, that your relative distance to the two objects doesn't change enough to change their angular size
  - Moon is 0.52° in diameter when viewed from Earth (Sun is 0.53°)
    - Arctan(384,000km from Earth / 3476km diameter of moon) = 0.0045 radians = 0.52°

Rule of Thumb = "**Half a Degree**" for sun or moon

- Example: For a 300mm crop sensor zoom lens, the horizontal angle of view is ~4°, therefore, a ~ 0.5° moon will take up about 1/8 of the frame of your photo and you have to be 1.4 miles away from a monument that you want to fill your frame
  - You are never going to be able to make the moon as tall as the monument…
    - You would have to be **11.2 miles away** with a 1200mm lens on a crop DSLR
      - The Earth curvature only lets you see 3.1 miles until the horizon…
      - Don't be fooled by "Supercalifragilisticexpialidocious Moons" that are photo-shopped

Perspective of Two Distances / Sizes

- Your relative distance to two different objects creates a perspective size difference between the two objects
  - **Lens does not affect size difference between objects**. It only affects how much of the scene you see
- You can match the size of the sun or moon with a famous landmark of your choosing
- Let's say you want the moon to perfectly fit behind the Washington Monument width
  - You know the width of the moon (0.5 degrees)
  - You can look up the width of the top of the Washington Monument (34.5 feet)
  - You can calculate how far away you have to be for 0.5 degrees of your view to equal 34.5 feet
    - 34.5 feet / tan(0.5°) = 3,950 feet (0.75 miles)
  - Therefore, you need to be 0.75 miles from the Washington Monument to have the moon be the same width
    - 7th street is 3840 feet away, Entrance to Air & Space Smithsonian is 4,400 feet away
    - Steps of Lincoln Memorial is 3,930 feet away (almost perfect!)
- The lens you have on your camera dictates how much of your frame will be filled with the moon and monument

Perspective Summary

- $\frac{\text{Size of object you are trying to match with the moon}}{Tangent\ (0.5\ degrees)} = Distance\ from\ Object$

$$\frac{\text{Object Size}}{0.008727} = Distance\ from\ object$$

115 * Object Size = *Distance from Object*

- **Rule of thumb to get you close** (then step forward or back accordingly)

Moon/Sun Size Matching Equation ***(patent pending, Tyler just came up with it…)***

~100 * Object Size = Distance from Object

(use 115 instead of 100 if you have a calculator)

Moon in Olympic Rings Example

(Photo Credit: Reuters from 2012 London Olympics)

- Rings are ~26 feet tall each
- Moon is ~0.5 degrees in diameter
- 26 feet / tan(0.5°) = 2,980 feet or 0.56 miles
  - Photographer had to be 0.56 miles away from London Bridge
  - Picked lens based on how much of the scene they wanted
- What else can you make "moon sized"?
  - Bending Tree Branch
  - Building Dome, Weather Vane, or Lightning Rod
  - Canyon arch
  - Width of Light House Tower
  - Gap between two skyscraper buildings (NY Field Trip?)
  - Person's arms or hula hoop (3 foot diameter = ~350 feet away)
    - Hula Hoop + Football Field = Fun Moon Photo

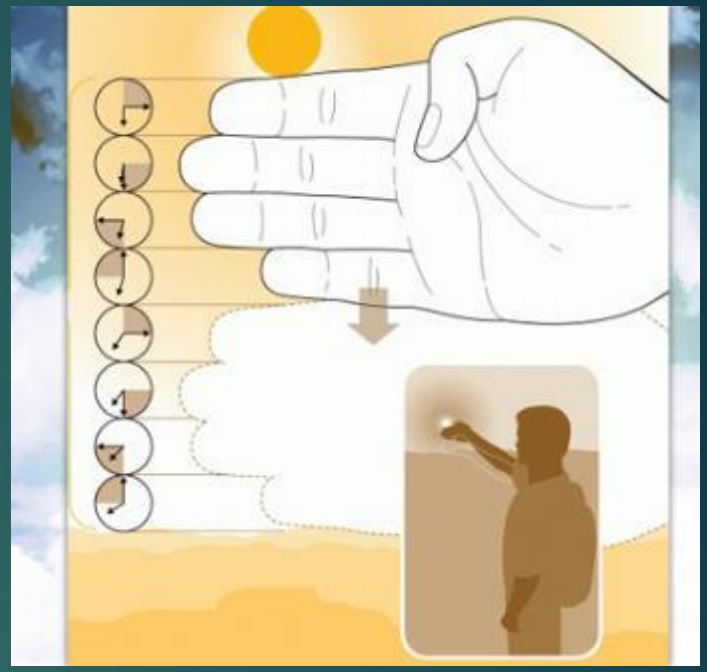
Low-Tech Sunset Trick ~15 minutes per Finger

- Ever wonder exactly how long to set up your shot before the sun sets?
  - At the beach? Want to grab dinner? You might have enough time…
- A good rule of thumb (pardon the pun) is that if you hold your hand out at full arms length, you can predict the timing of the sun

When holding your hand out at arms length

Each **finger represents 15 minutes** of sun movement

Four fingers of a **hand represents 1 hour** of sun movement

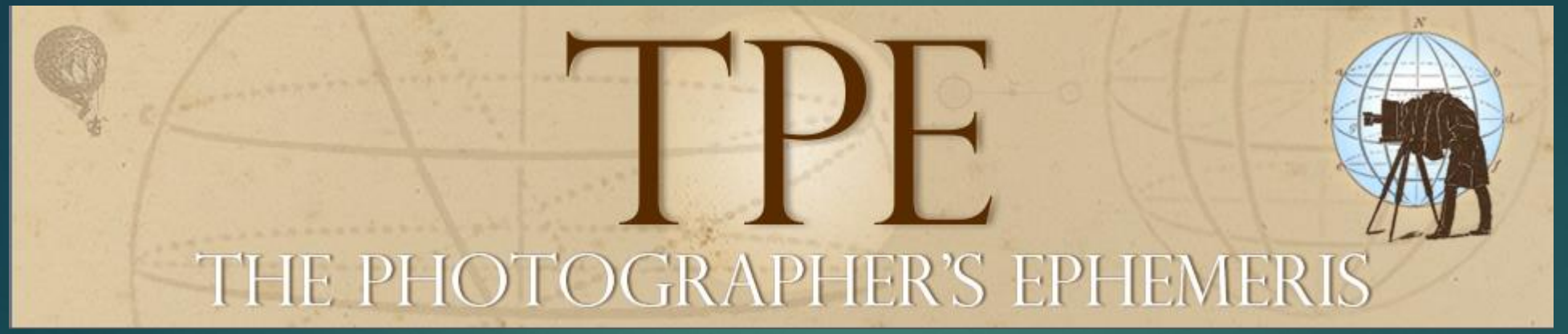


http://www.groovymatter.com/2012/08/remaining-daylight-on-your-fingers.html

- Can be calculated by thickness of your finger vs length of your arm vs distance to horizon (~3 miles) vs angular diameter of the sun (0.5 degrees)
  - Or you can just believe the rule of thumb as being approximate enough
- High Tech Sunset trick is to use The Photographers Ephemeris (Next few slides)

Let Technology Do the Work (TPE)

Computers and phones are good at math
Figure out where the Super Moon will rise before it rises



- **Photographer** *noun* *[fuh-tog-ruh-fer]*
  - A person who takes photographs, especially one who practices photography professionally

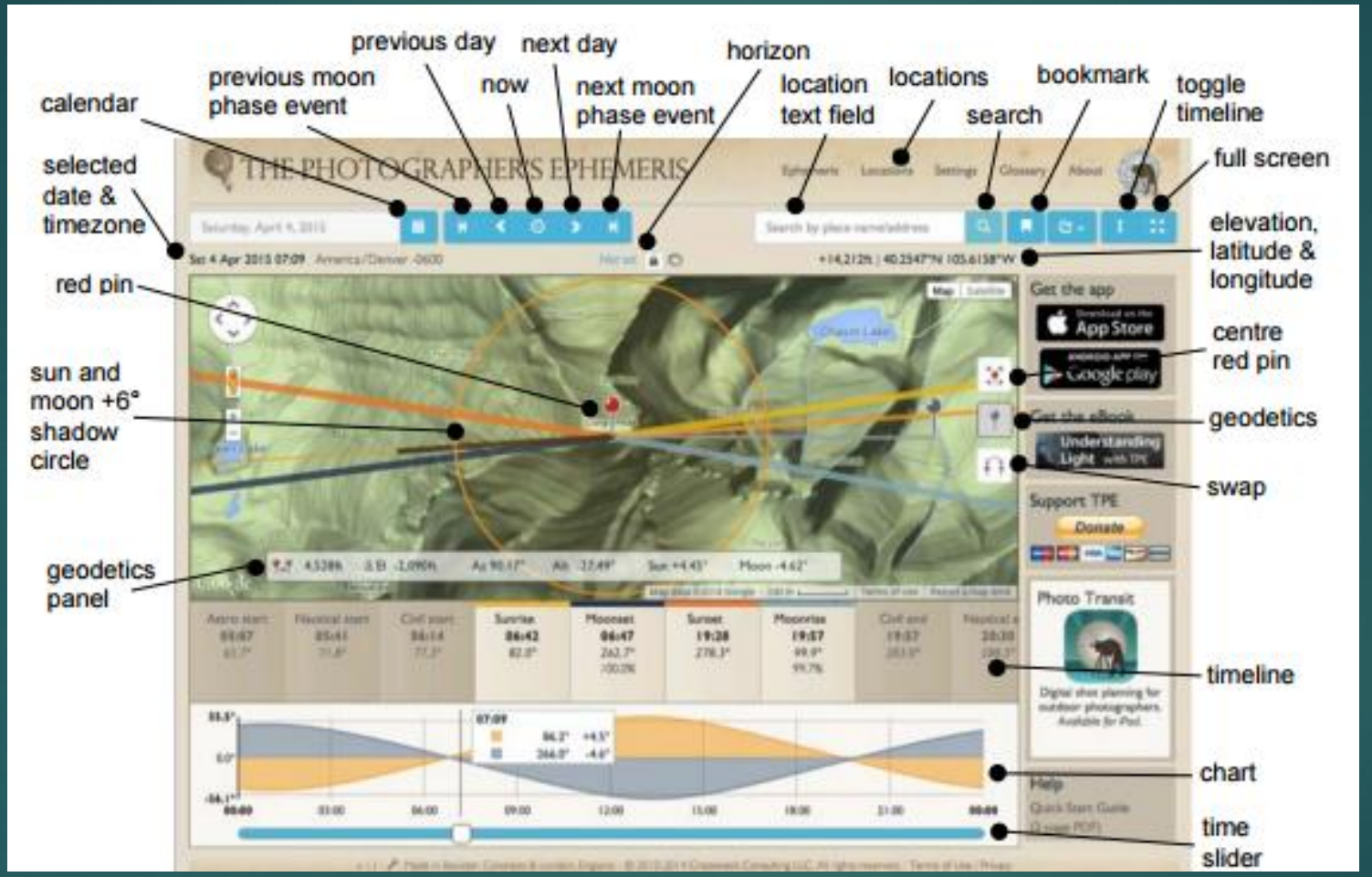
- **Ephemeris** noun [ih-fem-er-is]
  - A table showing the positions of a heavenly body on a number of dates in a regular sequence

The Photographers Ephemeris (TPE*)

(Will be referred to as TPE in future slides)

- Tool developed in 2009 after a landscape photography course in Rocky Mountain National Park in Colorado
  - Course required paper topographic maps, protractor, calculator, pencil, and ruler
  - Created computer program to do that all automatically
  - Desktop program released in 2009, iPhone app in 2010, Android in 2011, and in 2014 computer program was converted to just a web app
- New web-app means that you just have to go to the website with your computer to use it
  - Don't need to download a program and install it anymore
- Free tool, but they do accept donations through their website

TPE main features



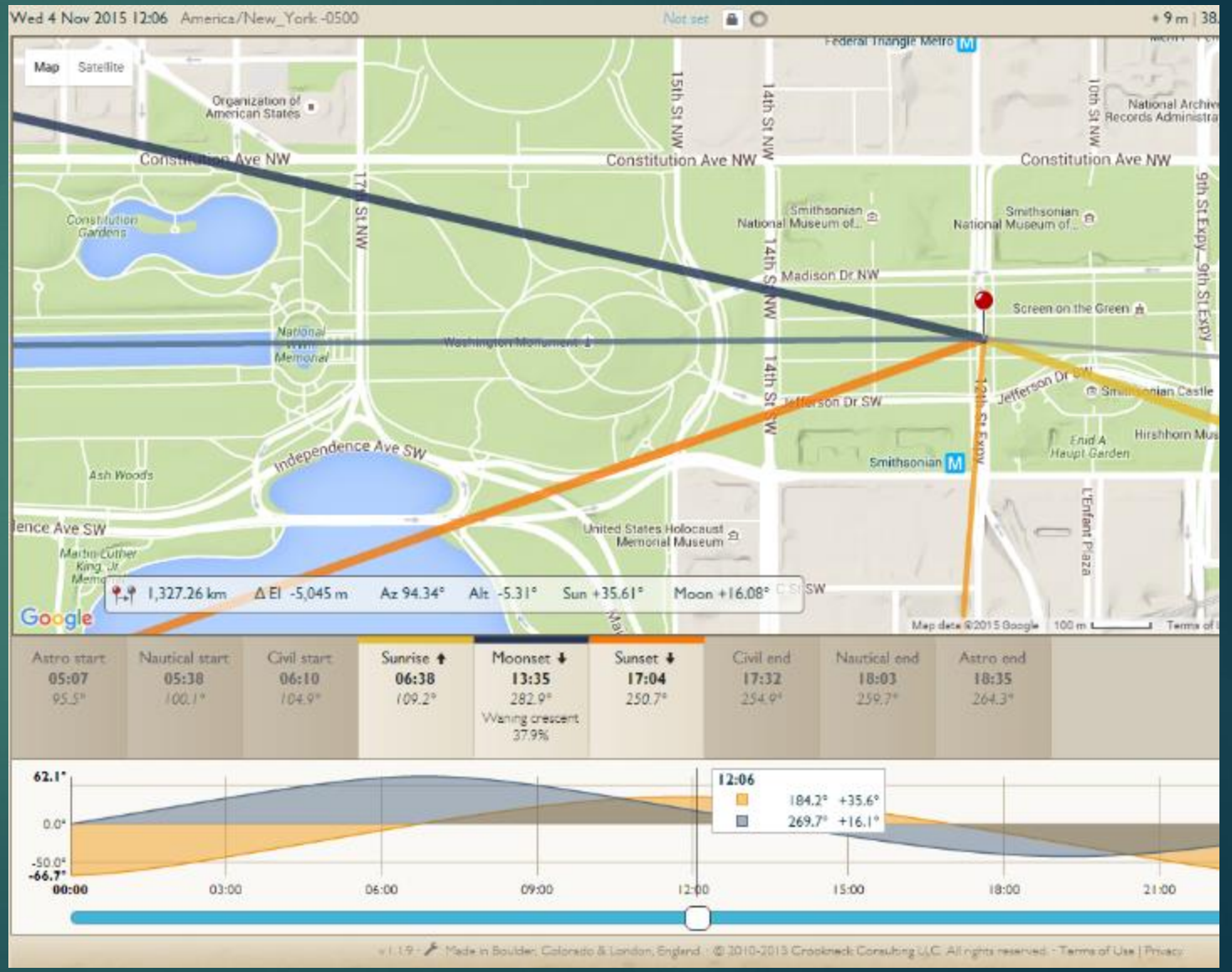
- Yellow and orange lines for sun path, blue-ish lines for moon path
- Lots of "knobs" to tweak such as date/time and location by moving dropped "pin"
- Lots of information fed back to user including times of events and location in angle

TPE Example 1 (Moon on Monument)

- Conditions Right now (Wed. 11/4 at Noon)
- Moon is lined up with Washington Monument and Lincoln Memorial
- Moon is 16° above horizon
- How far away to get Moon at top of Washington Monument?
  - Tangent(16°) = 555 ft / X
    - 555ft / tan(16°) = 1936 ft

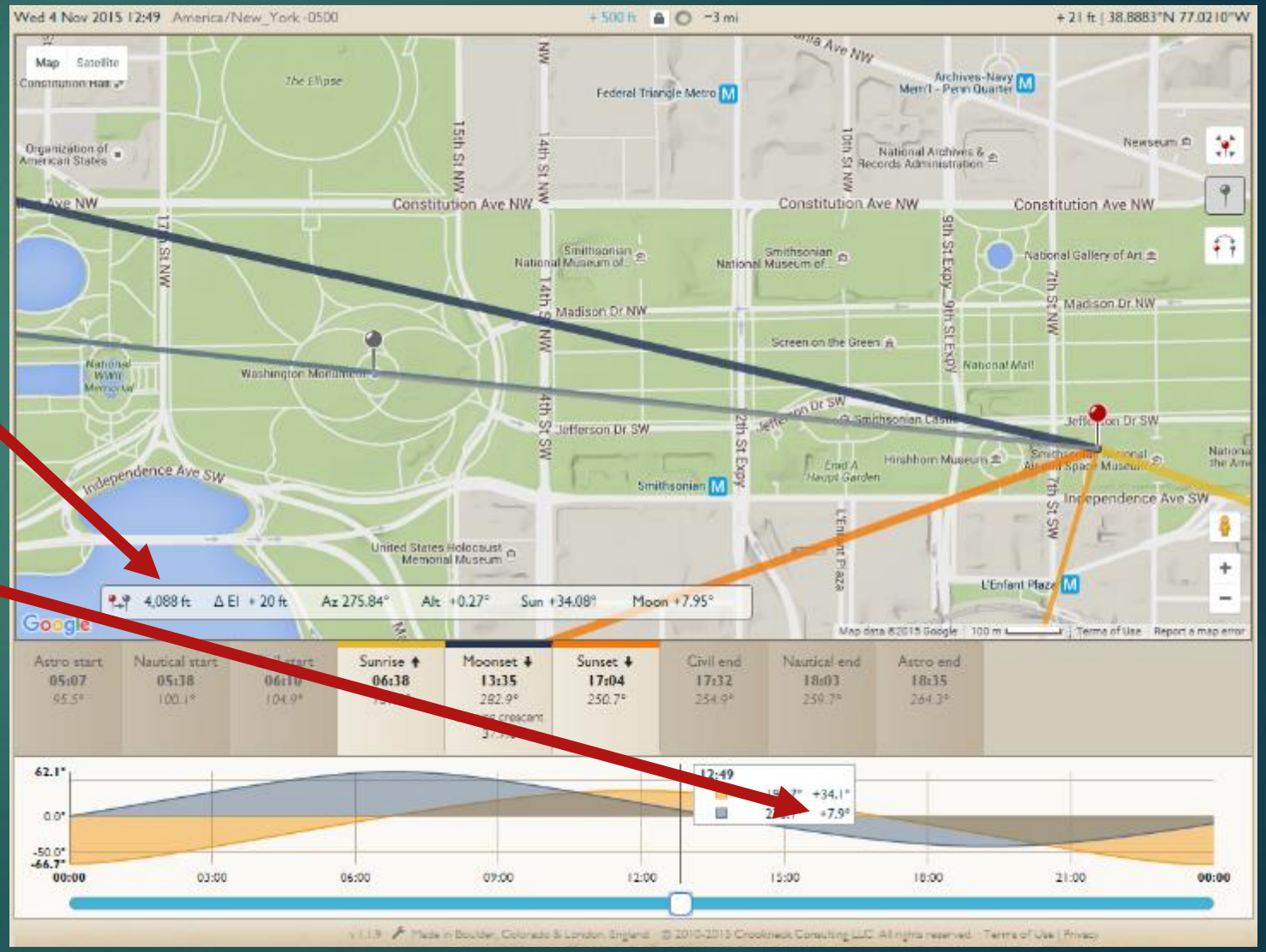
$$\frac{\text{Height of Object}}{\text{Tangent(Altitude Angle)}} = \text{Distance from Object}$$

  - 12th Street is 2000ft away



TPE Example 2 (Right Sized Moon on Monument)

- Earlier example calculated distance to get moon to match 34.5 ft wide monument
  - 34.5 * 115 = 4000 ft away
- How high does the moon need to be in the sky at that distance?
  - Tan(angle) = Height / Distance away
  - Angle = arctan (555 / 4000)
  - Angle = 7.9°
- Drag bottom blue time slider and move pin until moon is 7.9°
- At 12:45, just move farther away and South near Air and Space Museum
  - Buildings may block view
  - Can try different days in future to get it right

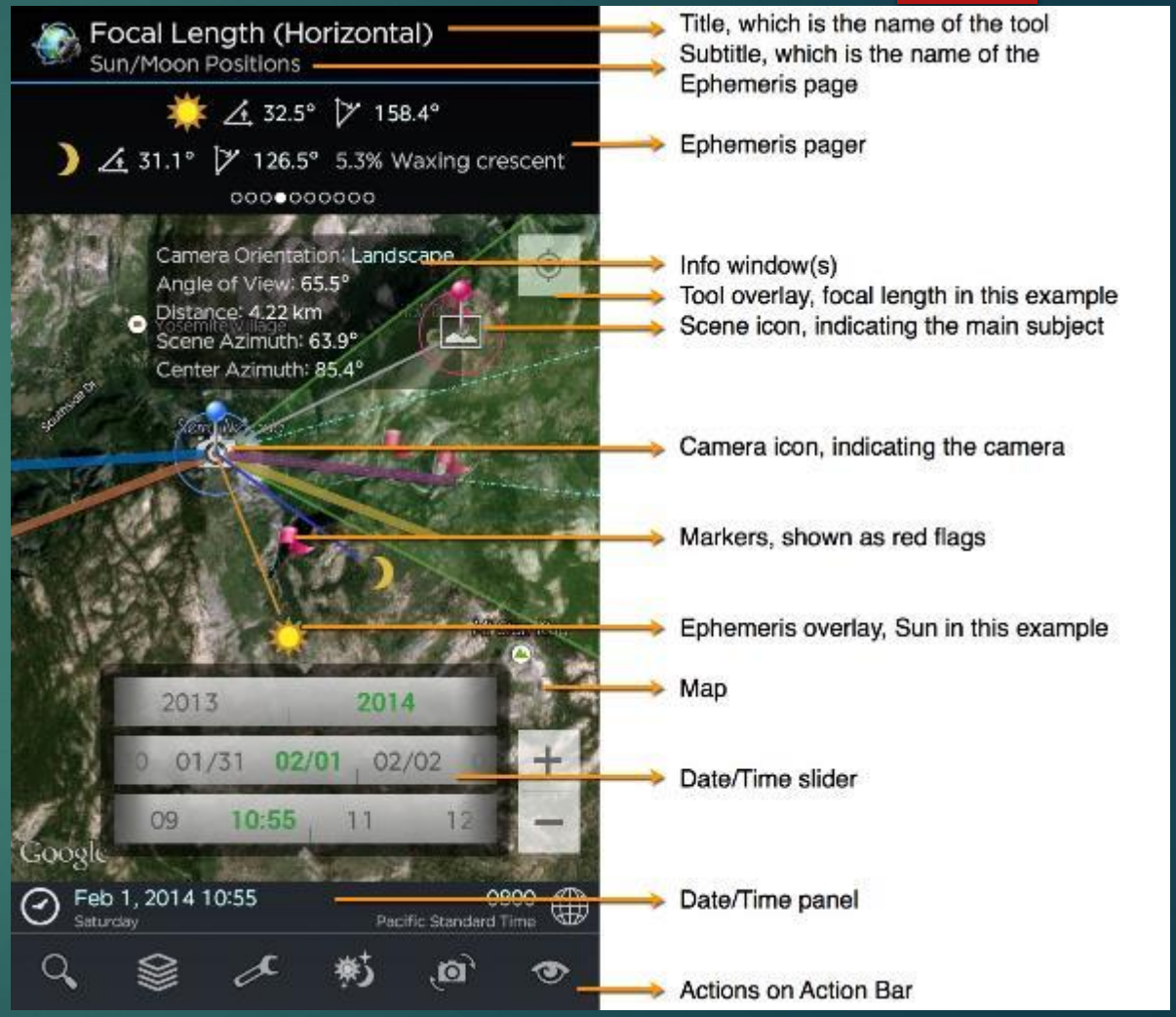


Let Technology Do the Work (PlanIt!)

Computers and phones are good at math
(All the features you could want, and the learning to go with it)

PlanIt! for Photographers

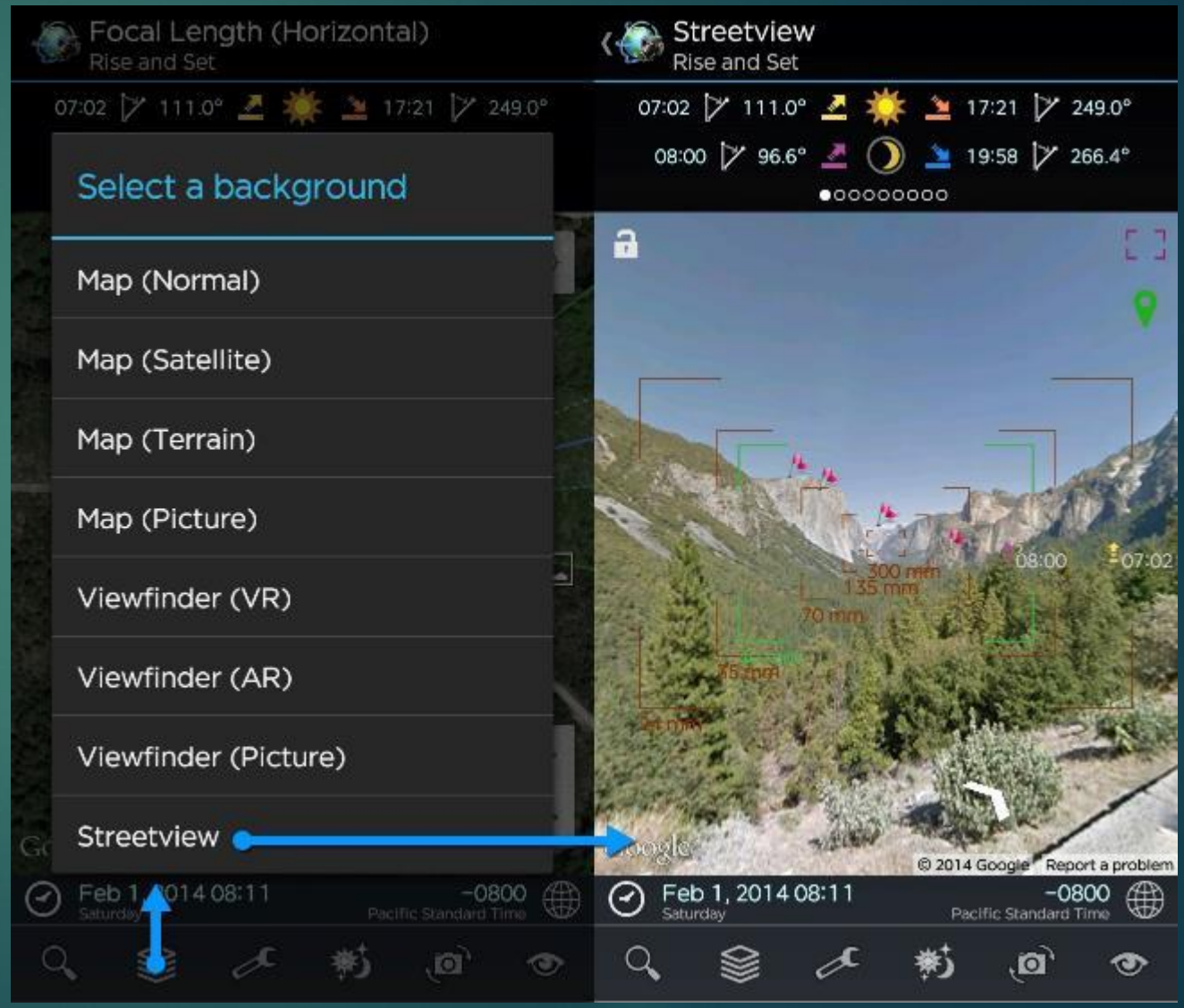
- PlanIt! For Photographers
- $6 app for iPhone/iPad or Android by Ying Wen Technologies
- More capability than TPE
  - Input your camera settings
  - View star positions, milky way stripe position
  - Use Google Streetview to preview your shot with overlaid camera window sizes by lens



http://www.yingwentech.com/planit/userguide/index.html

PlanIt! For Photographers

- Google Streetview compatibility is possible if data is available (it is in most cities)
- You can see what your camera would see before even visiting the location
- You will get an overlay of window sizes depending on what zoom lens you use
- Does the math for you!
- More powerful and customizable features, but that means more learning and manuals to read



http://www.yingwentech.com/planit/userguide/index.html

http://www.sensorgraphy.net/2014/08/plan-shot-planit-photographers/

Total Solar Eclipse

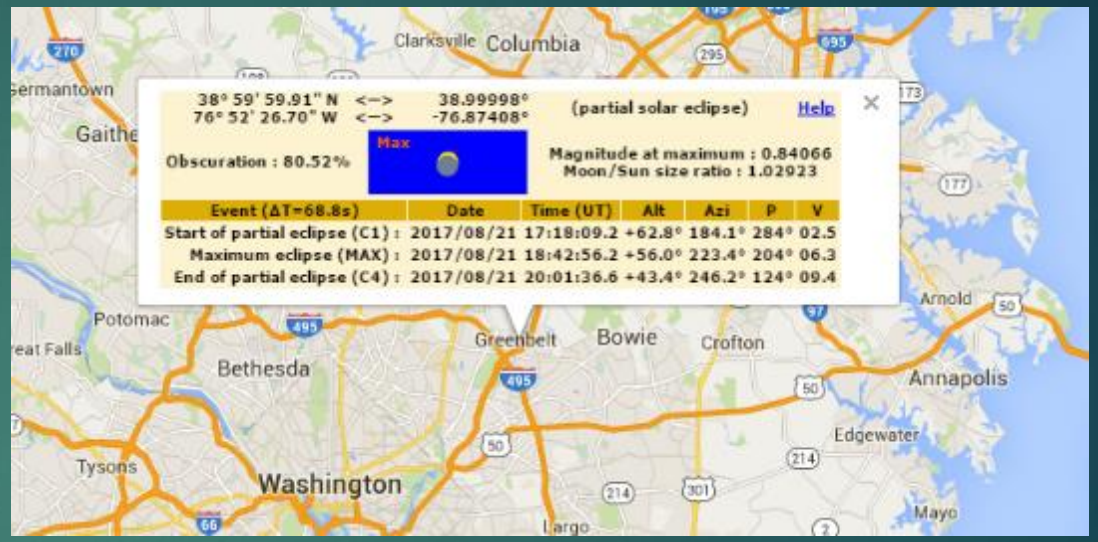
See you in the shadow in 2017

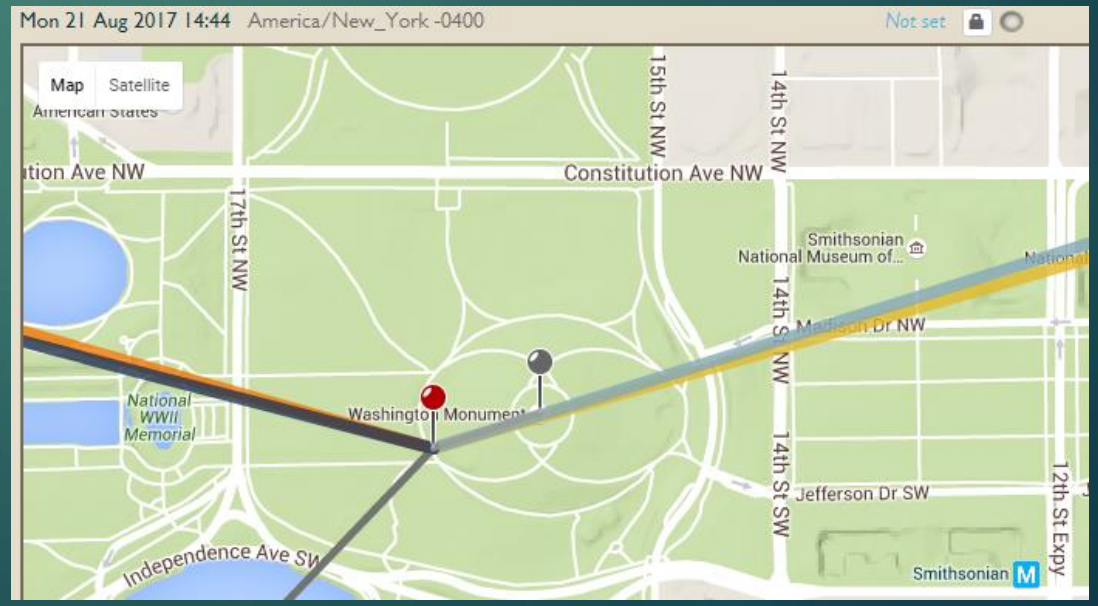
Total Solar Eclipse on August 21, 2017

- Start Planning Now!
- Travel to a total eclipse zone?
  - No equipment needed, can stare at absence of sun
  - Make sure there isn't cloud cover if possible
  - Maybe have a backup non-cloudy location
  - Not as many choices of monuments, since major cities aren't really on the path
- Do you want to stay where you are and not have it be a total eclipse?
  - Can plan around a major city monument
- http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2017Aug21Tgoogle.html
- http://www.eclipse2017.org/2017/path_through_the_US.htm

August 21, 2017 Eclipse in DC Area

- Even though Washington DC isn't on the direct path of the total eclipse, it will see a partial eclipse
- Graphic to the right shows local eclipse simulation
  - Will need eye-safe solar/welders glasses or strong ND filters to view/photograph directly
- Eclipse will be from 1:18pm to 4:01pm local time
  - Maximum Eclipse will be at 2:43pm (14:43)
  - Subtract 4 hours from Universal (Zulu/GMT) time to get to Eastern Standard Time (EST)
- Maximum Eclipse will be at 56˚ above horizon
  - What object do you want to match with the sun
  - How far away do you need to be from that object
- 375 feet SW from the Washington Monument the eclipsed sun will be on the top point of the monument…

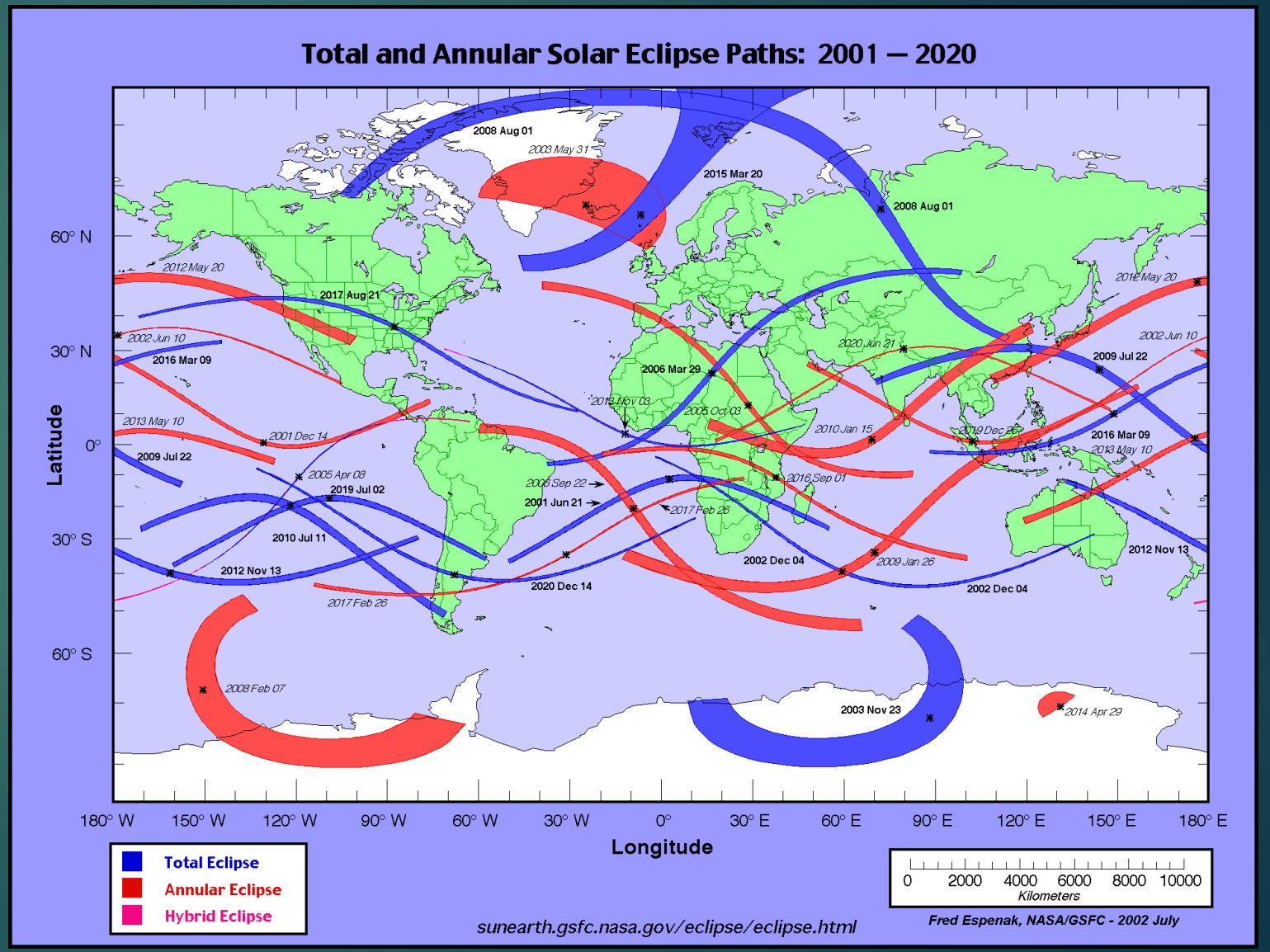




All Eclipses from 2000 to 2020

- Next Total Solar Eclipses in USA
  2017, August 21st
  2024, April 8th
  2045
  2078

- Only 2 Total Eclipses in the USA in the next 10 years
  - Then 20 years of waiting
  - Then 30 years of waiting



http://eclipse.gsfc.nasa.gov/solar.html

Sun in the City Streets

Henges aren't just made of stone (CityHenge)

Manhattenhenge

- Sun lines up perfectly with Manhatten streets around May 30th and July 12th every year
- Washington DC has events where the sun lines up with streets around September 22nd ("DC Hengeweek")
- Baltimore has an event where the sun lines up with the streets around September 18th (sunrise) and 29th (sunset)
- Article on Manhattenhenge

http://www.amnh.org/our-research/hayden-planetarium/resources/manhattanhenge

- Video of Neil deGrasse Tyson explaining Manhattenhenge

https://www.youtube.com/watch?v=iafX0awnxS8

https://apicciano.commons.gc.cuny.edu/files/2015/05/Manhattanhenge-1.jpg

Rules of Thumb Review

The one slide worth referring back to

Rules of Thumb

To make the moon or sun the same size as any object

100 * Object Size = Distance from Object

(If you have a calculator, use 115 instead of 100)

When holding your hand out at arms length

Each **finger represents 15 minutes** of sun movement

Four fingers of a **hand represents 1 hour** of sun movement

Angular Diameter of the Sun or Moon

"**Half a Degree**" diameter for sun or moon

Use TPE Altitude Angle to put Sun/Moon on top of an object

$$\frac{\text{Height of Object}}{\text{Tangent(Altitude Angle)}} = \text{Distance from Object}$$

Make sure you're still enjoying taking pictures

Have fun!